

Lecture 4

Analytical Chemistry

التاريخ

الموضوع

③ Percent by volume (v/v)% - The number of milliliters of solute per (100) mL of solution.

$$\text{Unit} \rightarrow \frac{\text{mL}}{\text{mL}} \% \quad (v/v) \% = \frac{\text{volume of solute (mL)}}{\text{volume of solution (mL)}} \times 100\%$$

★ Example: The concentration of ethanol solution is 10% (v/v) what is that mean?
mean that $\rightarrow$ 10 mL of ethanol is present in 100 mL of ethanol solution.

Example: calculate the percent by volume (v/v) of ethanol when 20 mL of ethanol was dissolved in 60 mL of H₂O.

solution

volume mass of solute (ethanol) = 20 mL

volume mass of H₂O = 60 mL

percent (v/v) = ??

① volume of solution = volume of solute + volume of H₂O
" " " = 20 + 60 = 80 mL

② percent of (v/v) % = $\frac{\text{volume of solute (mL)}}{\text{volume of solution (mL)}} \times 100\%$
" " " = $\frac{20}{80} \times 100 = 25\%$ v/v

يعني ذلك أ -

- 1- In 100 mL of CH₃CH₃ solution contained 25 mL of ethanol.
- 2- 25 mL of ethanol present in 100 mL of ethanol solution.
- 3- 25 mL of " dissolved in 75 mL of H₂O.



Mole fraction (X)الكسر المولي

mole fraction: The ratio of the number of moles of that component present in the solution to the total number of moles of all component of the solution.

الكسر المولي: العلاقة بين عدد مولات كل مكون في المحلول إلى مجموع عدد مولات المحلول.

The solution is mixture contain A and B.

$$n_A = \frac{n_A}{n_A + n_B}$$

$$\therefore n_A + n_B = n_t$$

$$f_A = \frac{n_A}{n_t}$$

الكسر المولي يرمز له بالرمز f

$$f_B = \frac{n_B}{n_t}$$

عدد مولات B في المركب
عدد مولات المركب ككل

ملاحظة هامة:

1- يجب أن تكون مجموع الكسور المولية للمكونات المركبة = 1
أو بمعنى آخر يجب أن تكون قيمة f أقل من واحد.

★ If the mole fraction is 0.4 what is the f for B for mole fraction for A?

$$\therefore f_A + f_B = 1 \Rightarrow f_B = 1 - f_A \Rightarrow f_B = 1 - 0.4 = 0.6$$

الكسر المولي لا يعتمد على درجة الحرارة. لذلك عندما نستورد المواد الخام نغيرها (نكدها) لأن هذه النسبة أقل تأثرًا بالحرارة مقارنة بـ (X).

ركز على ←

$$X_{AB} = \frac{n_A}{n_t}$$

$$f_B = \frac{n_B}{n_t}$$

Example :-

6g of NaCl was dissolved in 50g of H₂O to prepare NaCl solution / What's The fraction mole of NaCl

① mass of NaCl = 6g m.wt = 58.5 g/mole

$$n_{NaCl} = \frac{\text{mass(g)}}{\text{m.wt}} = \frac{6}{58.5} = \boxed{0.103 \text{ mole}}$$
 لازم نأول الكمية الى مولات

② mass of H₂O = 50g m.wt = 18

$$n_{H_2O} = \frac{\text{mass}}{\text{m.wt}} = \frac{50}{18} = \boxed{2.78 \text{ moles}}$$

$$n_{NaCl \text{ sol}} = n_{NaCl} + n_{H_2O}$$

$$n = 0.103 + 2.78 = \boxed{2.883 \text{ moles}} \rightarrow n_t$$

$$f_{NaCl} = \frac{n_{NaCl}}{n_t} = \frac{0.103}{2.883} = 0.036$$

هناك طريقتان لإيجاد الكسر المولي للماء (H₂O)

①
$$X_{H_2O} = \frac{n_{H_2O}}{n_t} = \frac{2.78}{2.883} = \boxed{0.96}$$

②
$$X_{H_2O} = 1 - X_{NaCl} = 1 - 0.036 = \boxed{0.96}$$

Molality (m)

molality is: The number of moles of solute per one kg of solvent.

عدد المولات للمذاب في (1) كيلوجرام من المذيب.
التعبير الوحيد الذي يستخدم في المذيب (solvent) هي المولالية.

$$m = \frac{\text{moles of solute (mole)}}{\text{mass of solvent (kg)}} = \frac{m \text{ of solute (mole)} \times 1000}{m \text{ of solvent (g)}}$$

وحدة القياس $m = \text{mole/kg}$

ملاحظة إذا كانت وحدة القياس جرام (g) فنضرب $\times 1000$

Example: (1)

The concentration of NaCl solution is 2.30 m what does mean
mean that 2.30 mole of NaCl dissolve in 1 kg (H₂O)

example (2):

15.24 g of (H₂SO₄) (mwt = 98 g/mol) was dissolved
in 198 g of H₂O what is the molality of (H₂SO₄)

mass of H₂SO₄ = 24.4 g m. wt = 98 g/mole

mass of H₂O = 198 g

نسبة المولات $\frac{H_2O}{H_2SO_4} = 2$

$$n_{H_2SO_4} = \frac{\text{mass}}{\text{m.wt}} = \frac{24.4}{98} = 0.248 \text{ mole}$$

$$m = \frac{\text{mole of H}_2\text{SO}_4}{\text{mass of H}_2\text{O}} = \frac{0.248}{198} \times 1000 = 1.252 \frac{\text{m}}{\text{mol/kg}}$$

part per Million and part per billion PPM and PPB

① Part per million (PPM)

is the number of gram of solute per million gram of solution

هو عدد جرامات المذاب على مليون جرام من المحلول
القانون .
$$C_{PPM} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^6$$

The unit $\mu\text{g/g}$ or mg/kg or mg/L or $\mu\text{g/mL}$

EX: solution whose solute concentration is 1 PPM
what's mean:

mean 1 μg of solute per 1 kg of solution

② 1 ~~mg~~ 1g of solute per $(10^6)\text{g}$ of solution

Part of billion (PPB)

is the number of (g) of solute per billion (g) of solution

القانون $\rightarrow C_{PPB} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^9$

The unit ng/g or $\mu\text{g/kg}$ or ng/mL

$1 \text{ PPM} = 10^3 \text{ PPB}$ (العلاقة التي تربط بين PPM و PPB)
 $\leftarrow = \text{PPM}, \text{PPB}$

EX: The concentration of solution is 15 ppb and the mass of solution is 300g. what is the mass of solute in gram?

$$\text{Solution: } \rightarrow C_{ppb} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^9 \text{ ppb}$$

$$15 \text{ ppb} = \frac{\text{mass of solute}}{\text{mass of solution}} \times 10^9$$

$$\text{mass of solute} = \frac{15 \text{ ppb} \times \text{mass of solution}}{10^9 \text{ ppb}}$$

$$\text{mass of solute} = \frac{15 \text{ ppb} \times 300 \text{ g}}{10^9 \text{ ppb}} = 4.5 \times 10^{-6} \text{ g}$$

مسألة (exercise) 20

Q When 6.0 g of NaCl was dissolved in 66 g of H₂O to prepare 8.33% (w/w) NaCl solution, the density of NaCl solution is $\rightarrow$ 1.21 g/mL. calculate.

- 1) The mass of NaCl solution.
- 2) The volume of NaCl solution.
- 3) The percent of NaCl in unit (w/v)
- 4) The strength of NaCl solution
- 5) The mole fraction of NaCl and H₂O
- 6) The molality of NaCl solution
- 7) The concentration of NaCl in unit ppm

solution

mass of NaCl = 6 g $m.w.t_{NaCl} = 58.5 \text{ g/mole}$ mass of H₂O = 66 g
 $d_{NaCl sol} = 1.21 \text{ g/mL}$ $w/w\% = 8.33\%$

$$w/w\% = \frac{\text{mass of NaCl}}{\text{mass of NaCl solution}} \times 100\%$$

$$8.33\% = \frac{6 \text{ g}}{\text{mass of NaCl solution}} \times 100\%$$

$$8.33 = \frac{600 \text{ g}}{\text{mass of NaCl solution}}$$

$$\text{① mass of NaCl solution} = \frac{600}{8.33} = \boxed{72.1 \text{ g}}$$

$$\text{② } d = \frac{m}{V} \Rightarrow V = \frac{m}{d}$$

$$\text{Volume NaCl solution} = \frac{\text{mass of NaCl sol}}{\text{density}} = \frac{72.1}{1.21} = \boxed{59.58 \text{ mL}}$$

$$\textcircled{3} \text{ percent (w/v) \%} = \frac{\text{mass of solut}}{\text{volume of solution}} \times 100 \%$$

$$= \frac{6}{59.58} \times 100 = 10.1 \%$$

$$\textcircled{4} \rho = \frac{\text{mass of solute}}{\text{volume of solution}} = \frac{6 \text{ g}}{59.58 \text{ mL}} \times 1000 = 100.7 \text{ g/L}$$

حزب 1000 $\times$ $\frac{\text{كتلة المذاب (g)}}{\text{حجم المحلول (mL)}}$ (L)

$$\textcircled{5} X_{\text{NaCl}} = \frac{n_{\text{NaCl}}}{n_t}$$

$$n_{\text{NaCl}} = \frac{6}{58.5} = 0.103 \text{ moles}$$

$$n_{\text{H}_2\text{O}} = \frac{66.58.5}{18} = 3.67 \text{ moles}$$

$$n_t = 0.103 + 3.67 = 3.77 \text{ moles}$$

$$X_{\text{NaCl}} = \frac{0.103}{3.77} = 0.03$$

$$X_{\text{H}_2\text{O}} = \frac{3.67}{3.77} = 0.97$$

$$\textcircled{6} m \text{ of NaCl solution} = \frac{m_{\text{NaCl solution}}}{\text{mass NaCl solution}} \times 1000 = 52.29 \text{ m}$$

$\frac{0.103 + 3.67}{72.1} \times 1000$

$$\textcircled{7} \text{ ppm NaCl} = \frac{\text{mass of NaCl}}{\text{mass of NaCl solution}} \times 10^6$$

$$= \frac{6}{72.1} \times 10^6 = 0.08 \times 10^6 \text{ ppm}$$